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NATIONAL DEVELOPMENTS

PROBLEMS IN SCIENTIFIC, TECHNICAL POLICY DETAILED

Tianjin KEXUEXUE [SCIEENOLOGY] in Chinese No 2, 1980 pp 47-48

[Article by Shanghai Institute of Scientology: "Ten Major Problems of Current Scientific and Technical Policy"]

[Text] In order to better understand the viewpoint of the mass of scientific and technical personnel and cadres regarding current scientific and technical work and to provide reference material for leadership policy making, we took advantage of the end of a seminar for Shanghai scientific and technical leadership cadres to use the Delphi method ["expert collective forecasting method"] for a series of consultations with 45 scientists, engineers and scientific and technical management experts.

The Delphi method is a rather advanced survey method. It avoids the limitations and errors of judgement of individual experts and also can avoid the errors of conference-type surveys. The main faults of past conference-type surveys have been that generally they have been polarized by two authoritative opinions, particularly those of the first few speakers. This is not only because as soon as an authoritative opinion is given others are constrained from speaking their views out of politeness or but also because these opinions may explicitly influence other people's thinking so that everyone thinks along the same lines. The results of such surveys are quite one-sided. Another fault of survey meetings is that if two or more viewpoints arise they may either become deadlocked, so that the experts cannot give free consideration to other people's views and it becomes difficult to for the survey to come up with correct results. Under conditions of small-scale production, the problems are relatively simple and the atmosphere is relatively frank and straightforward, so that survey meetings generally are quite productive. But under conditions of large-scale socialist production, the faults of the method have a strong effect. Accordingly, the Delphi method has been developed. According to this method, several experts are canvassed several times in isolation from each other so as to avoid the abovementioned faults, resulting in a rather scientific approach.

The topic of this forecasting work was: "What do you think are the ten problems in scientific policy most urgently requiring solution?" We requested that each expert consider the question independently without discussing his answers with others and give his choices in order of importance. The 45 experts answered conscientiously, and some comrades gave detailed reasons for each choice. The total of 450 opinions were processed and classified as 93 different problems. On this basis we chose the twenty problems on which opinion was most concentrated and held a second

round. We asked everyone to select 10 problems from among the twenty and to rank them in order of importance. The aim of the second round was to enable experts to consider other experts' opinions and to further concentrate the problems. In this round, after the twenty problems were printed up, the survey was conducted by letter and interview.

Below we present the results of the two-round survey:

1. On the basis of the overall results of the two survey rounds, the ten major problems, in order of importance, are as follows:

- a. Rapidly using a scientific approach to draw up a plan for the scientific and technical development of Shanghai, drawing up specific short-term, mid-term and long-term measures to mobilize and organize Shanghai's scientific and technical forces and to take full use of Shanghai's scientific and technical advantages, reap results and scale new heights.
- b. Expanding the autonomy of scientific research units. Scientific research should also be conducted according to economic laws and the scientific research topic contract system should be implemented. In addition, the corresponding powers of personnel assignment, planning and distribution of funds should be further expanded.
- c. The five major scientific research armies should be uniformly directed by the municipal scientific and technical committee. Research topics should be uniformly arranged and coordinated and low level duplication avoided. The military and civilian systems should be brought into the same orbit. According to their capabilities and quality, some existing research institutes should be readjusted and expanded and others contracted. Similar or closely related research organizations should be coordinated into research centers. Long or short term, complete or one-topic cooperative agreements should be used to strengthen lateral relationships between brother organizations.
- d. Rational job titles, dissemination methods, wage policy and a degree system should be developed on a uniform basis. Particular attention should be given to the titles and degrees of scientific research management personnel.
- e. Scientific research personnel management should be reformed. Effective measures should be taken to give scientific personnel mobility. Personnel in advanced schools and research units should have constant contact with each other. Personnel not suited to the scientific research should be rapidly separated from the research units so that full use will be made of personnel and other fronts strengthened. Scientific and technical personnel's work should take full account of their individual interests. Those people who have achievements should be given awards and those who keep talent down should be penalized.
- f. Organization, legislation and economic methods should be used to strengthen scientific and technical bonds between basic research, practical research, developmental research and production so that the results of scientific research will be converted into productive forces as fast as possible. Price, taxation and other policies should be used to support dissemination of the results of scientific research and the production of new products.

g. The material situation of scientific and technical personnel should be improved as rapidly as possible and the necessary living conditions, residential conditions and study conditions provided. Legislation should be instituted regarding living conditions which separate scientific personnel from their wives, and all situations which meet the conditions should be immediately set right.

h. The evaluation method and awards system for scientific research results should be improved and the relationships between basic science and development science, between technology and processes, between research personnel, technical personnel and management personnel, and between scientific thought, technical proposals and specific implementation should be effectively handled. Those who make a contribution to scientific planning should be given major awards.

i. The party's leadership of scientific research should be strengthened and improved, and standards for party leadership in scientific research units should be drawn up. Party members who are scientific and technical personnel with management ability should be given leadership posts at various levels. Laboratory heads and party branch secretaries should be jointly responsible for political duties and should not deviate from scientific practice.

j. A citywide scientific and technical information network should be set up and kept updated.

2. The selection rate for the various problems was as follows:

Sequential number of problem	Selection rate
1	85.6
2	85.6
3	82.8
4	66.8
5	54.3
6	54.3
7	54.3
8	51.4
9	48.6
10	48.6

3. The number of first place selections for the different problems in the second round was as follows:

Sequential number of problem [as listed in section 1]	Percentage of first place selections
1	58
3	20
2	15
9	7

It can be seen that the statistical approaches show considerable concentration of opinion, and the first, second and third opinions should be given particular attention.

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NATIONAL DEVELOPMENTS

MANAGEMENT OF NEW PRODUCT DEVELOPMENT ANALYZED

Tianjin KEXUEXUE [SCIEENOLOGY] in Chinese No 2, 1981 pp 15-20

[Article by Zhang Zhongxiu [1728 0112 0208], Liu Ji [0491 0679] and Jiang Juguang [1203 5112 0342]: "Management of New Product Development and Some Suggestions for Its Improvement"]

[Text] New product development is an important aspect of the scientific system and of enterprise economic activity. It determines the enterprises' future fate and direction and the standards of the national economy. The question of how to modernize backward products and use progressive sets of equipment to remake the various department of the national economy has become urgent. In a certain sense it can be said that the rate of development of new products will directly determine the speed and level of our country's four modernizations. Because of prolonged sabotage and interference by Lin Biao and the "gang of four," our new product development work universally has a long cycle time, low standards, a low rate of putting products into production, and large numbers of problems, so that it requires serious attention. A sample analysis which we made of 749 new types of complete-unit products produced since 1968 by 35 electrical and mechanical equipment plants in Shanghai indicates that the cycle time between design and fabrication of the first model was 1 year in 26 percent of cases, 2-3 years in 58.1 percent of cases, and 4 years or more in 15.9 cases. Some 18.5 percent of the products were at an advanced domestic level or up to 1960's standards, while only 5.3 percent were at an advanced international level or up to 1970's standards. Only 33.5 percent went into lot production (including a small number of items which went into production and were only repeated once). It should be pointed out that these statistics do not deal with the entire development cycle from design to evaluation and the organization of production. In reality, many problems are only uncovered in debugging after trial production of the first experimental models. The debugging cycle generally is even longer, and the time required for several trial production cycles longer yet. Why is this the case for new product development?

Six Major Management Problems

Naturally there are many technical problems in the development of new products, but as many technical personnel have said, "In the last 2 years we have had many contacts abroad, and we have come to realize that advanced foreign technology is by no means at an unattainable level. We have thought through many of the problems which foreigners are considering, and have even thought them out better. But the foreigners

have gone ahead and have been successful, while in the past we did not dare say what we thought, or if we did say it we could not act on it, or if we did act on it we were not successful." This is where the true difference lies. Backwardness in management has gravely hindered our forward progress. Currently there are six major problems in new product management.

1. Haphazard Task Assignment and Evaluation

The initial setting of new product development assignments is done without scientific forecasting of market demand and technological development. The administrative departments simply put together a set of tasks on the basis of requests by certain individual users and send them down. The overall needs of national economic development cannot be simply equated with the needs of a few particular users, in particular since this country puts no economic restrictions on the users, so that whenever they want they can rescind technical agreements and development contracts, change design parameters at will and refuse to take on tasks. Accordingly, many users' requests are not rational, so that the development of many products has failed from the very beginning to fill any need. Second, there is a lack of technical and economic substantiation. The abovementioned sample analysis indicated that the development of 80 percent of new products was undertaken without technical substantiation, and with almost no economic analysis. Third, this country has no special technical investigation department or system. As a rule the administration and management departments do this work, and inspection and approval at the various levels generally merely involves collecting the proposals and affixing the stamp at each level, thus amounting to no more than a formality. Fourth, inspection of design proposals was undertaken for only 43.5 percent of new products in the sample analysis, and even these inspections were of the conference type. There are no requirements regarding the qualifications of the inspection personnel, and they lack any technical authority; in addition, the inspection personnel have neither powers nor responsibilities, but are limited to making comments which have little effect.

It should be pointed out that in the past, development of new products was generally done in the form of a campaign, with considerable sloganizing, such as the large-scale efforts in fluidics, silicon controlled rectifiers and the like. The result was that initially there was a bustle of activity, then the work would become bogged down, and finally there would be a burst of action. This type of "big push" approach, without scientific forecasting or substantiation, without integrated planning or balance, based on headlong mass action, is certainly not a scientific way of developing new products or technologies.

Not only the assignment of projects, but evaluation of the results too is extremely haphazard. On the basis of our sample analysis, 62.9 percent of the new products which were put into lot production were not subject to formal evaluation. Even if there was an evaluation, it was similar to the design proposal investigation meeting, and had no real effect in checking on technology. Accordingly, many products still had large numbers of technical problems after evaluation, and could only be produced with their faults, resulting in long-term bottlenecks. The problems with some products were not thoroughly solved even by the time they were discontinued. Because evaluation is haphazard, there is no practical monitoring of the quality of the initial assignments, producing a vicious circle.

2. Lack of an Effective Form of Organizing Design

On the basis of our sample analysis, currently 68.8 percent of designs are produced by the plants alone. In reality, many plants have a weak technical contingent, and no real design capability. The design is nothing but "copying." Design was done cooperatively by the producing factory, a scientific research organization and the user factory in 21.2 percent of our cases. But both independent design and cooperative design were actually dispersed design, where each organization was a law unto itself. Products which were widely produced in large numbers inevitably had the problem of a multiplicity of varieties. This not only produced subsequent difficulties in organizing their standardization and adaptation to series production, but also led to losses from the scrapping of large amounts of industrial equipment. As a result, for many years there has been stress on and promotion of nationwide integrated design by factories of the same type, particularly in the case of major products; this would make it possible to pool wisdom for overtaking and passing advanced producers and to implement series production, standardization and design for broad applicability. This type of design approach accounted for 10 percent of cases. But experience indicates that it is not living up to expectations, and under the present management system it is becoming a hindrance to developing new products. There are several problems:

(a) A long cycle for integrated design. First, the work of the administrative organizations wastes large amounts of energy and time. When the work is finally organized, in a situation of regional isolation, the various plant representatives arrive at the meetings armed with directives from their leadership, and administrative aims are given priority technical discussions. In addition all of the plants have their own process conditions and design traditions, and they all want to prevail. Accordingly, there are many disputes. It frequently happens that the various design proposals are all but irreconcilable, and it is very hard to unify them.

(b) The quality of integrated design is low. Because the standards of the various plants differ, ultimately a compromise design proposal is adopted. In particular, when a new technology is created, it generally cannot achieve recognition by the majority at first; this is a general law of scientific and technical development. Accordingly, in integrated design, creative technological proposals are very difficult to get approved, especially when many units are subject to particularism, and their representatives are not key technical personnel, so that the gathering is not made up of highly qualified specialists. Accordingly, the level of integrated design generally is mediocre or slightly above, so that no real progress is achieved.

In addition, integrated design cannot really be implemented, because after the representatives return home, the individual plants change the design according to local administrative requirements, their own process conditions, materials supply and the like, so that within 2 or 3 years everything is in chaos.

3. The Policy of "Science Leading the Way" Has Not Yet Been Implemented

At present most new product development is not preceded by scientific research as a reserve for technology, and in the development process the necessary specialized studies are rarely done; designs are simply made on the basis of foreign documents,

so that the work is not development in the full sense of the word. There are two main reasons for this situation:

First, the harmful effects of the "five simultaneous" approach have eliminated scientific experimentation. The so-called "five simultaneous" approach of "do research while doing design while testing while debugging while putting into production" is entirely at odds with scientific procedure. While research still has no exact results, on what basis can one do design? Again, if scientific research is not used to guide design, it loses all its value. Of course, the scientific procedure is not absolute. Under certain conditions, specific organizational work can have some overlap. But overemphasizing certain partial and secondary factors in opposition to the main essence of the work is the common characteristic of all "ultraleft" trends. The ultraleft slogan of the "five simultaneous" approach has for a long time been praised as a revolutionary principle. During the time when Lin Biao and the "gang of four" held sway, it was especially elevated, while they simply encouraged the "four no's" ("no drawings, no raw materials, no calculations") in design. But the rashness of some leaders has assured that the "ultraleft" slogans still hold the stage. Their intentions may be good, but they lack the spirit of seeking for truth and are always hoping that some evening they will be "holding a golden child." The haphazardness of evaluation generally has fostered this tendency. Science must progress gradually, and a headlong rush, heedless of procedure, generally fails to achieve the necessary speed. We have suffered too much of this kind of loss too often.

The second reason is that conditions for experimentation are few and scattered and lack any planning. During the period when Lin Biao and the "gang of four" held sway, science was in a disastrous condition, and most scientific bases were ruined. Some research institutes were dissolved, some laboratories were dismembered, and the pernicious consequences still make themselves felt. A few members of the leadership did not, in either understanding or action, treat the establishment of laboratories as an inseparable aspect of new product development. They paid attention only to research and development tasks and took few of the necessary steps to assure that scientific experimentation was carried on. At the same time, because of the habits of small-scale production, the construction of laboratories lacked an overall plan. Each unit had a bit of equipment, but it did not add up to a set. One group might have one thing and another group another, or everybody would have the ordinary things and nobody would have the critical ones, with the result that there was no way to carry on the necessary research. Some large and important equipment could not be bought by anyone, so that it simply was not available. Sometimes groups would make contributions to establish it in one organization, but it could not be thoroughly or rationally used. All of these factors made it impossible to conduct serious scientific experimentation and new product development.

4. Neglect of Basic Components and Processes

When new product development is conducted abroad, the developers have various types of good-quality, cheap standardized basic components available, while in this country, when developing a basic machine or set of equipment, it is also necessary to develop the requisite basic components. Even if some basic components are available, they generally are of poor quality and seriously hold back the development of new products. For example, we have achieved a very high standard in unit engineering for axle

bearing noise, a level of only 40.2 dB, which is better than similar Japanese products. But the axle bearings which are currently produced in large lots have very serious noise, exceeding international standards, which has a direct effect on the competitiveness of a wide range of mechanical and electrical products such as electrical machines, machine tools and air conditioners, on the international market. The key reason for this state of affairs is that the leadership lacks an adequate understanding of the universal effects of basic components. In the past the slogan "make a major effort to provide sets, work hard on the basic elements" was universally advocated. It meant focusing on assembling sets of equipment, and in order to get sets together it meant a temporary effort to develop basic components; but when a few sets had been produced, that was considered to be enough and there was no general plan for basic components. When investments were made, basic components were not included, so that it was very hard to make series-produced products available, and their quality was very unreliable. At the same time, in projects involving sets of components there was a one-sided stress on the policy of "local provision of sets," which on the one hand forced plants producing basic components to be "small and self-contained" and produced a multiplicity of product standards, while on the other hand a given locality had no way--and no need--to produce all varieties, but could only temporarily piece together single-item production.

The structure of basic components is in general not complicated, and the main question is that of obsolete processes. In the case of axle bearing noise described above, an important factor is the precision of the balls; but a certain steel ball plant which wanted to use an advanced steel ball process produced a total of 20 reports over a period of 5 years, but to this day it has not been able to get the proposal on the agenda. In reality obsolete processes are the key not only for basic components but for the development of entire machines and sets of machines as well. Taking medium and low power diesel engines as an illustration, according to statistics, when 73 shortcomings of our products with respect to advanced foreign technologies were examined, 92 percent were directly or indirectly related to materials and processes. Progressive design must be backed up by modern processes. It is necessary to include process research and modernization in the plan at the very beginning of new product development. But for a long time the relevant leadership personnel have made it a design principle to plan on the basis of existing technology, and what they call "process investigation" means that if the shops cannot handle a design, it has to be altered; in such a situation, how can there be advanced products? The situation in this country, in which many processes have not been changed for several decades, must be altered.

5. Limited Research Funds and Their Ineffective Use

In this country, funds for new product development are primarily allocated by the state for specific line items, and are small amounts. Research funds for the First Ministry of Machine Building account for only 0.15 percent of the total budget, while funds for new product development and scientific research for the Shanghai No 1 Mechanical and Electrical Machinery Bureau account for only 0.25 percent of total output value. These figures are much less than such foreign figures as 3 percent of total sales in Yugoslavia and Romania, and 5-8 or even 10 percent in western Europe. As regards absolute values, large foreign companies spend as much as several hundred million dollars a year on research and development, which represents an even greater gap. Although money is limited, if we focused its use rationally and

carried on research on a few products each year so as to achieve the proper benefit, over a period of years a great effect would be produced. But the problem of ineffective use of funds is still rather serious. The main problem is that funds are excessively dispersed. New product development in this country is carried out simultaneously by the academies of sciences, advanced schools, research institutes, large and small plants, and plants of the same type jointly. In particular, the "big push" approach of the past, in which funds were spread over a wide area, in addition to the situation in which the various units are "large and self-contained" or "small and self-contained," do "all-purpose research" and attack many topics, even using 1 or 2 people per topic, results in the allocation of a pit fully small amount of money to each project. In this way they merely duplicate each other at a very low level, lacking sufficient personnel or material and financial resources for any profound research. The products consistently fail to come up to standards, and there is no way to improve their technical level. No technical or economic effect can be obtained from spending the money in this way. Currently, a close look should be taken at some leadership departments which gradiosely stress that "even small plants can run research institutes." For example, the country's grinding machine industry is small, but it has always had a grinding machine research institute; now, however, eight grinding machine research institutes have been added to the First Ministry of Machine Building system. Most of them duplicate each other in terms of approaches and tasks. Does this not fragment our country's grinding machine research funds?

6. Existing Enterprises' Evaluation Methods and Economic Policies Are Irrational

The key reason that plants in our country have universally lacked initiative in new product development for a long period is that enterprises' evaluation indicators are incapable of comprehensively reflecting the enterprise's contribution to the state and are in contradiction to the development of new products. More personnel and financial and material resources must be expended on new products in the development stage, but in the case of mechanical and electrical products, output value and profit are still below those of old products 2 to 3 years after production has been begun. Although once process technology has matured and lot size has increased, higher output values and profits can be achieved for new products, the evaluation indicators in this country's existing enterprises are calculated on a year by year basis, so that the enterprises' interests suffer from a short-term viewpoint. The situation is even worse in many cases when the development of new products focuses on improving capabilities, with some increase in material and process requirements, so that there is a need to increase production costs somewhat: this comes into conflict with existing plants' requirements that costs must decrease every year. As a result, the leadership of many plants say quite frankly: "New product development is unrewarding: if we are unsuccessful we lose our bonuses, and how can we explain that to the employees?" This is another of the critical reasons that the research results of research units cannot be disseminated rapidly. A certain plant and research institute cooperated energetically in developing new products, filled a gap in our country's vacuum cryogenics technology and vigorously promoted the development of our country's national defenses and sophisticated industries; and in recent years they have received 31 awards at levels ranging from municipal to national, but their profits in 1978 amounted to only 4.5 yuan per person, and the amount that could be distributed to the employees was only a little over 1 yuan, while other plants in the same corporation had more than 100 yuan per person for distribution. This shows quite clearly that the current enterprise accounting methods take no account of their immense contribution to the state. To sum up, with current account-

ing methods, although new product development is beneficial to the state as a whole, it is unprofitable to the plant; although it is beneficial to the plant in the long term, i.e. is unprofitable in the short term. This acute contradiction seriously dampens enterprises' enthusiasm for new product development.

In addition, under current pricing policy, high quality cannot attract high prices, the state does not choose the best quality products for investment, tax policy is irrational and so on, all of which dampens enthusiasm for improving old products and developing new ones.

Our Suggestions for Improvement

Scientific management is large-system engineering, and must take account of all possible factors, strike a comprehensive balance and try to attain the optimum technical and economic effects. It is quite common in management activity that neglect of a single factor can cause failure. Accordingly, improvement of new product development management cannot concentrate on one aspect to the exclusion of the others, nor can it simply work on individual symptoms or devote effort to one aspect in a way that does harm to the others. Although these approaches can produce results in a limited context, their success cannot be sustained, and they hinder overall improvement and accordingly are major management shortcomings. Accordingly, the reforms should, as far as possible, form a complete, closed system and should be brought into agreement with the entire economic management system. On the basis of this realization, we believe that we cannot simply and formalistically propose policies to deal with the abovementioned six problems, but must seek a fundamental, comprehensive method of solution. We should like to propose the following preliminary suggestions for everyone's joint investigation.

1. Cooperation and Division of Labor on the Basis of an Overall Plan

a. Specialization and division of labor are preconditions for rapid high-quality development of new products. We must overcome local isolation and create reasonable deployment and coordination for specialization. If Shanghai has very favorable conditions for specialization, Shanghai should be used as the focus. If Qinghai has the best conditions for some specialization, Qinghai should be the focus. We should also put an end to departmental isolation, and specialized corporations should use whatever organization will yield the best technical and economic results. In this way, all provinces and municipalities and all departments will bring their strengths into play, cooperate with each other, and form a flourishing economic network which will overcome the past faults of unnecessary duplication in development and lack of manpower for many hard-to-fill occupations. In this way we will develop new products which truly have a market and will use our limited manpower and financial and material resources on the cutting edge and accelerate the pace at which we catch up with the rest of the world.

b. Science, technology and production should divide the work and join forces. The academies of sciences, advanced and intermediate academies and schools, and the industrial departments' research organizations, planning centers, producing factories and users should practice division of labor and cooperation in the overall process of developing new products so as to achieve an overall balance. The academies of science and the advanced and intermediate schools should concentrate on basic theoretical research, the industrial departments' research organizations should concen-

trate on basic theoretical research, the industrial departments' research organizations should concentrate on practical technical research, the design centers should be in charge of specific product research, the workers should concentrate on process testing and improvement, and the user organizations should provide feedback. The new product development assignment must be subjected to effective technical analysis, it should be undertaken by the relevant scientific and technical departments, with the strength of each brought into play, and a relay across the whole range from research to production should be developed, for only in this way can we have an advanced new product development capability.

c. There should be a comprehensive balance between sets, single machine and individual components. The ultimate aim of new product development is to provide modern sets of equipment to satisfy the people's economic needs. Without sets there is no productive force. An overall balance presupposes a set of technologies. The user or the producer or a specialized corporation for provision of sets should be able to arrange the supply of specific sets of components, depending on the nature of the product. But the basis of complete sets is individual machines, and the basis of these is in turn individual components. Accordingly, the basic matters must be taken care of first in the comprehensive balance. In particular, such general-use items as electrical machines, hydraulic components, seals, axle bearings and gears are the basic components which affect many industries, and there should be an overall plan to set up our own standardized series production on the basis of overall market needs and forecasts so as to provide a full selection for the development and putting into production of individual machines. We must institute a new awareness that only by consistently providing a good selection of good-quality basic components can we assure timely development of high-quality machines and sets of machines when they are needed.

Once the division of labor and comprehensive balancing are carried out in the above three areas, each level must have the requisite right of management of personnel and financial and material resources in its own area. We cannot have all the work being done by the lower levels while all the powers are concentrated above, nor can we expand enterprise autonomy so far that we grant all powers to the lower levels. We believe that such relevant powers as overall planning, assignment of the major tasks and standardization should be properly centralized, while administration and management powers relative to new product development should as far as possible be granted to the various enterprises (or specialized corporations).

2. Set Up a Rational Process Technology Research System

New product development is a component of engineering technology which should be studied not only in order to create new technologies, new structures, new materials and new processes, but also in order to systematically accumulate large amounts of design data and curves. This must precede production and must not be mingled in with production. It must be provided with the best personnel and financial and material resources, rather than having them duplicated and dispersed as at present. Abroad, the modern company is not equivalent to a production plant. A typical modern enterprise includes a scientific forecasting office, a research and development department, a production plant and a sales system as well as an education center. Within the research and development department there is division of labor into research and development divisions: the former is in charge of research organizations engaged in exploratory technical research and practical basic research, while

the latter specializes in new product research and development, carrying out various activities from the utilization of various technical research results to evaluation and the fixing of a definitive design. The production plant only takes on the tasks of producing products in their definitive design. We believe that this is a law manifested by modern industrial practice and development and is worth careful attention. We may adopt it in keeping with our own country's characteristics and in a critical manner. Our specific comments and suggestions are as follows:

- a. We must invigorate and strengthen centrally-subordinated research institutes, and those which duplicate each other's work should be suitably combined or the labor divided among them, while institutes which are lacking should be newly created. These research institutes' main task is to conduct exploratory practical technological research, to serve as national technical forecasting centers, information centers, data processing centers and experimental centers, and to act as consultative organs and technical inspection organs for technological decision-making by central ministries and bureau leaderships (including adaptation to series production, standardization and design for broad applicability).
- b. As specialized production takes place under this form and specialized corporations are created, the requisite research institutes should be set up at the specialized corporation level. In addition, design centers should gradually be created to take on tasks for the corporation ranging from technical information and market forecasting to technical design for sets and new production development. The producing factories will gradually specialize in high-quality, high-output, low-cost, safe production of products of definitive design, as well as process improvement and final quality control where needed. In this way it would be possible to fundamentally overcome the current situation in which there is great duplication in new product development and personnel and financial and material resources are highly dispersed. This should particularly be the case in industries which cover a wide area and have many plants. As for those industries which cover a narrow area and have only a few plants, plant-run research institutes can be set up in the main plant on the basis of specific conditions.
- c. The research institutes must select research personnel from the plants. They must centralize scientific instrumentation and equipment and assure that it is modern and that complete sets of it are on hand, so as to assure complete technical authoritativeness. Without this authoritativeness no research institute can be viable. In order to assure this technical authoritativeness, evaluation of research personnel must be intensified, and people who in practice are shown to be unsuitable should be transferred in a timely manner to other suitable work; at the same time, new personnel should constantly be attracted. In addition, in keeping with the needs of research topics, specialized research personnel may be brought in. To summarize, only by constant progress is it possible to assure that the institute will never stagnate.
- d. This type of research institute must have salaries above those in the plant, and working forms and conditions and management methods must be suited to the characteristics of mental work. Otherwise the best people will not come to the research institute or will have no incentive to stay, which is currently a widespread problem.

e. The corporation's (or principal plant's) research institute's development funds should be allocated from the corporation's or principal plant's share of profits. Currently 2 to 5 percent of that money is suitable. The specific percentage should be determined comprehensively by the upper echelons in terms of the degree of development required by the industry, the complexity of the varieties that are being developed and the degree of difficulty of making a profit. It should also be suitable adjusted every year in terms of changes in the situation. Major research projects assigned by the state should be accompanied by a suitable allocation of resources in accordance with the specific circumstances.

f. New product research tasks should be assigned as a set following comprehensive balancing of personnel and financial and material resources, supply of materials and instrumentation, and cooperation as regards components. Scientifically assigned projects should be allocated sufficient personnel and financial and material resources and provided sufficient guarantees. Not one person or one cent should be assigned to those projects which should not be undertaken.

g. The activity of the research institutes should be based on the economic responsibility system and the economic contract system to assure coordination of economic interests, economic responsibility and economic results, and to combine state, collective and individual interests.

We believe that this type of project research system is a one which is in accordance with scientific, technical and economic laws. The Shanghai No 7 Valve Plant and its three associated semifinished products plants (refining, casting, and forging) organized a general valve plant. This general plant set up a research laboratory which included modern scientific equipment for experiments on temperature characteristics. It brought together more than 50 highly skilled design personnel for unified valve design, and it has a specialized new product development shop. We believe that this laboratory embodies the trend to modern specialized research institutes. The present moment, when the various industries are readjusting, is an excellent time for setting up specialized corporation research institutes; for example when the dispatching room of a long assembly line plant is being reorganized it can refrain from all or most basic construction tasks, so that the corporation research institute can play a technical role as soon as possible.

3. Developing Management Methods for New Product Development

Law is the embodiment of the ruling class' ideology and the sum total of the various areas of the use of state power to constrain human activity. In order to accelerate the four modernizations, modern management must be regulated by law. The various management levels have their own laws. Once a rational mechanism has been established, laws should be enacted for management, so that everyone has a law to follow and can operate automatically. We believe that at least the following three laws should be enacted for new product development:

a. A law on designating research topics. One error in assignment of a topic quickly multiplies, producing much needless waste. Accordingly, special market requirements forecasting and technical development forecasting teams should be created in the relevant departments (e.g. the research institutes). These should carry out consistent forecasting work so as to provide sufficient scientific data

for assignment of new product development topics. Each new product development task must be thoroughly substantiated by technological and economic analysis. In general, development tasks are only based on technical, economic and social results, and the three should be weighed in combination. There also should be a specialized technical investigation office and system. The investigators must have sufficient technical qualifications, and must have particular powers and responsibilities and be subject to rewards and penalties.

b. A law on evaluation. There should be a unified system for evaluating and rewarding results. All results in the field should be uniformly evaluated by the relevant office (such as a specialized research institute) on the basis of state-established evaluation procedures, and given a scientific and correct evaluation as regards technical, economic and social value. Then the upper-level cognizant units should issue evaluation conclusions and awards. Only this type of fair evaluation can correctly stimulate production and encourage progressiveness and can make it possible to overcome the current formalistic approach of conference-type evaluations and negative factors in evaluation and rewarding of results.

The main task of the upper echelon leadership should be energetic work on the assignment of projects and evaluation, while they should not intervene excessively in their intermediate process, which should be an area for their subordinate units to show their activism and creativity.

c. A law on design. A unified law on design should be adopted for series-produced products and for designs intended for parts of sets so as to overcome the existing faults of dispersed design and joint design. The so-called unified design system involves unified design by technologically authoritative units (such as the research institute or leading plants of specialized corporations) designated by the upper level management on the basis of established design policy, or designation of a technologically authoritative overall chief designer who himself selects the best qualified design personnel and organizes a unified design group. The unified design unit or group should listen extensively to the opinions of sister organizations and specialists, but it has the right of technical decision making. At the same time, it has technical responsibility. The leadership organs can investigate design proposals so as to set conditions. In the design of products with broad use produced in large quantities, two or three units or small groups can be encouraged to do the work, so as to create technical competitiveness, after which the best design can be selected and put into production. As regards the degree of high-echelon control of unified design, a specific analysis and determination should be made on the basis of the technical characteristics and use requirements of the different products, and a conscious effort made to unify without excess rigidity and to give flexibility without chaos.

4. The Enterprises Themselves Should Have an Incentive To Develop New Products

Politics should be in command in the socialist enterprise, and it should persist in taking a view of the overall situation and putting the needs of the state first. At the same time, enterprises' evaluation methods and financial and economic policies should be reformed so that the enterprise itself will be powerful internal impetus toward new product development. The key to reform is making older, obsolete products unable to survive, and progressive products produce reliable profits. Our specific suggestions are as follows:

a. Depending on the different renovation characteristics of new products, it should be established that after from 2 to 10 years the product's price should gradually be lowered. At the same time, profit indicators should naturally be increased from year to year. If only the price is increased and the profit indicators are not controlled, old products will have increased sales on the market; if only the profit indicators are increased and the price is not dropped, the plant can increase its output of old products to meet its indicators. Only when these two factors are used in tandem will it be impossible to continue with backward old products.

In addition, increasing taxes can be an adjustment lever.

b. Suitable measures should be taken when new products are replacing old ones in the plant. Major new products should not be subject to taxation when they are first being put into production, and if suspension of taxes still does not make up for the plant's losses, the state should provide the necessary funds. Before large lot production of new products has been organized, while costs are rather high, the state should decrease the tax guidelines or even provide necessary subsidies. In addition, in the process of new product development or experimental production, suitable adjustments should be made in evaluation indicators for the plant's older products.

c. The user should have the right, under unified organization, to select and order goods. The state should supply the relevant materials and motive power on the basis of the size of the orders. We should resolutely correct the situation of "the large rice pot" system. The state may close, combine, or convert some plants whose products are backward and which have had losses for long periods. Although this will create certain economic losses, in terms of long-term state interests it is beneficial. Choosing the lesser evil in order to gain future profit is the dialectic of management.

d. A timely price adjustment should be made on the basis of high prices for high quality goods, and the principle of no price changes for products of fixed design should be altered to a principle of relatively stable prices. On the basis of changes in production and market conditions, a unified adjustment of prices should be made at fixed intervals for all products. Large increases should be made in the prices of nonstandard specialized products; this both helps make the production plant enthusiastic about the assignment and encourages the users to use standardized products. Large increases should be made in the prices of nonstandard specialized products; this both helps make the producing plant enthusiastic about the assignment and encourages the users to use standardized products as much as possible.

e. Scientific experimentation and industrial production have different characteristics and laws. Scientific experimentation is even more different from general administrative activity. Accordingly, financial management should use a differentiated approach.

The above 18 points are an interconnected, organic whole. They undoubtedly have many imperfection and require further consideration, but they must not be separated from one another. If only one of two points are adopted, they may have no effect and be impossible to implement. For example, if without taking steps to establish technical authoritativeness a research institute is set up in only a formalistic manner, it will not be able to achieve the desired result. Naturally these sugges-

tions are only one possible program. If their principles are correct, they will require further refinement. Thus administrative work is extremely toilsome. For a long period some management departments have taken only a simple approach focusing on output and tonnage, making no changes for several decades; this type of management is not toilsome, but it in fact entails a series of difficulties in the future development of new products, and in addition entails great difficulties for development of the national economy. People should make a fundamental break with traditional concepts. Economic management does not mean functioning in bureaucratic fashion: it is a science. Squares and circles cannot be drawn without the proper instruments. Science has its own internal laws, and if they are broken, research may be vitiated.

8480
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APPLIED SCIENCES

RESEARCH ON CIRCULAR ARC GEARS DESCRIBED

Shanghai JIXIE ZHIZAO [MACHINERY] in Chinese No 4, 1981 pp 2-4

[Summary of a speech by Lei Tianjiao (7191 1131 6030) of the Mechanical Science Institute of the First Ministry of Machine Building: "Direction of Circular Arc Gears Research in China"]

[Text] This evaluation conference is an overall review of the work in China on circular arc gears in general and double circular arc gears in particular. By summarizing the work in this area we will have a better understanding of circular arc and double circular arc gears. Generally speaking, carburized, quench hardened involute gears may be safely replaced by tempered, precision hobbed circular arc gears under the conditions that linear velocity is less than 80 m/sec and $K = 15 \text{ kgf/cm}^2$ or less. What about greater linear velocities? In my opinion there is no big risk either. Naturally calculation, manufacture and assembly should all be made very carefully before gears are used at high linear velocities. For gears that are subjected to heavy load, greater reliability and generally longer service life are expected of circular arc gears, be it single circular arc or double circular arc. In the past, involute gears are usually machined with digital milling cutter. This machining method is rather crude and the basis of comparison is therefore not precise. But it can be said that circular arc gears are quite appropriate and more reliable than involute gears for heavy load applications such as gears of steel rolling machine. For example, the steel mill circular arc gears presented in this meeting have been in service for 11 years and rolled 3 million tons of steel.

I. Comparison of the Three Tooth Forms

The objective of our development of circular arc gears is not to retire involute gears. Both single circular arc gears and double circular arc gears have their intrinsic merits. The goal of our research is to provide us with another means and another technique so that we may achieve better economic results. Take the gears often used in today's high speed transmission with linear velocities in the neighborhood of 70-80 m/sec: it is necessary to grind the involute gears and their production cycle is therefore very long. By switching to tempered, precision hobbed circular arc gears, we not only eliminated the need for manufacturing gear grinders but also reduced the cost. Hence, the gear hobbing machine is used to machine circular arc gears as well as involute gears and our flexibility is greatly increased. Since each type of gears has its intrinsic merits, each has its own optimum realm of application.

Since involute gears are totally insensitive to the center distance, flexibility is increased considerably in adopting displacement gears. In the past, floating structure was successfully used in some maritime gears and cement ball grinder gears. One of the key reasons for the success of planetary gears in recent years is that the pinion at the center has no bearing and it is floated and centered by the interaction forces of the three planet wheels. As a result, the load is uniform. This cannot be achieved without using involute gears. In addition, involute gears can be made highly precise, they can be made with zero clearance. This feature is very valuable to the meter industry.

Conversely, one of the most important intrinsic advantages of circular arc gears is that their relative radius of curvature can be at least 5-6 times that of involute gears. Circular arc gears not only have strong resistance to pitting but are also very favorable to forming lubricant oil film because of their high sliding speed in the relative motion. This should be an important direction of our research. Another advantage is that their sliding friction velocity is the same everywhere and hence they have good running fit properties, wear evenly and their accuracy is higher the longer they are used. This feature is very favorable to simultaneous contact of all the teeth. Naturally, higher coincidence coefficients are desirable for any type of gear. For circular arc gears, wear improves the uniform load distribution of adjacent teeth, whereas for involute gears, excessive wear will deteriorate their performance because they wear differently from addendum to dedendum and near the pitch line and two ends.

As compared to single circular arc gears, the greatest advantage of double circular arc gears is their high bending strength. At Zhangchun Motor Vehicle Parts Plant No 9, double circular arc gears with a module of 4 were used in comparison tests on a bevel gear hermetic test stand. Some 20 pairs of $m = 9$ arc bevel gears were destructively tested on the test stand and the trial can be considered rigorous. In addition, Zhangchun Motor Vehicle Parts Plant No 9 also produced several hundred pairs of precision cast double circular arc gears with rare earth nodular cast iron. They are used as part of the second shift speed reducing gears in Liberation brand trucks. Among the three vehicles examined recently, one has a mileage of 130,000 kilometers and the other two have mileages exceeding 80,000 kilometers; no damage was found. Moreover, since the coincidence coefficient is almost doubled, pitting resistance is also improved.

Single circular arc gears have their unique advantages too. In designing involute gears, we often try to move the contact zone behind the pitch point. This can be achieved only with considerable effort, especially for arc bevel gears. For single circular arc gears, the contact can be made in front of the pitch point or behind the pitch point. Naturally engagement behind the pitch point is desired. In bench tests we indeed found that gears with contact before the pitch point are more likely to jam. Although this phenomenon has not been clearly observed in the actual course of production, it is still safer to arrange the contact zone after the pitch point. This can easily be achieved in single circular arc gears but not in double circular arc gears.

All in all, we should have as many methods as possible at our disposal so that we can make use of all three gear profiles--single circular arc, double circular arc and involute gear--at will. We will choose whichever type that is most suitable for the application to obtain the optimum technical and economic results.

II. Pressure Lubrication of Circular Arc Gears

In the following we will highlight the advantages of circular arc gears from the viewpoint of lubrication. For circular arc gears, the relative radius of curvature between tooth faces perpendicular to the contact direction is 5-6 times that of involute gears. This is highly favorable for lubrication. According to Reynolds equation:

$$\frac{\partial}{\partial x} \left(\frac{h^3}{1+\mu} \frac{\partial P}{\partial x} \right) + \frac{\partial}{\partial y} \left(\frac{h^2}{1+\mu} \frac{\partial P}{\partial y} \right) = \omega x \quad (1)$$

where P is pressure, μ is viscosity, h is the gap, ω is angular velocity, x is the distance between the center of the contact to the edge of the instantaneous contact area, h is approximately equal to x^2/ρ and ρ is the relative radius of curvature.

The first term of the Reynolds equation represents the amount of oil leaked in unit time and unit area along the length of the tooth. The second term represents the amount of oil leaked in unit time and unit area along the depth of the tooth. The term on the right-hand side of the equation represents the amount of oil carried into the contact area due to the rolling motion. For simplicity, we neglect the second term because it is only a small proportion. Thus, we have

$$\frac{\partial}{\partial x} \left| \frac{x^6}{\rho^3(1+\mu)} \frac{\partial P}{\partial x} \right| = \omega x \quad (2)$$

If we wish to have pressure oiling, the pressure required is very high. According to calculation based on Hertz equation, the contact stress at the tooth face can be as high as 5,000-6,000 kgf/cm². From Equation (2), we can see that a greater ω will help to carry in more oil and a greater ρ will increase the resistance for oil leaking out. When ρ is doubled, the resistance will be increased 8 times. Since the relative radius of curvature of circular arc gears is 5 times greater than that of involute gears, the resistance is increased more than 100 times and the situation is naturally highly favorable for the formation of oil film. Furthermore, the viscosity μ of the lubricating oil is not a constant, but depends on the pressure exponentially:

$$\mu = \mu_0 (e)^{Kp} \quad (3)$$

in which μ_0 is the viscosity at normal pressure and the value of K , the normal lubricant index, is usually 0.028. Therefore, viscosity is increased 7-8 times under 1,000 atmospheres of pressure, 40-50 times under 2,000 atmospheres of pressure and can be 100 times or more for higher pressures. Thus the viscosity of the oil is very high and it is entirely possible to form pressure oil film between tooth faces.

Several observed phenomena may serve to prove this point. For example, measurements made on one set of double circular arc gears in Xian with 3 years service time (more than 2,500 hours) revealed that the common normal only decreased 0.01 mm. This can be regarded as within measurement error and there

was essentially no wear off. Another example is the double circular arc gears of the 506 air compressor that we have seen at Wusong Chemical Plant. With 3,000 hours of service, the contact zone does not show extrusion band and the width is not large. The contact band in high speed gears sometimes stops widening even after long service time; indicating that the wear stops after the high points are worn off. This because a complete oil film is formed and the film may be very thin. Of course wear at low speed still exists. For example, wear of 0.25 mm cannot be considered to have a film of oil.

The existence of oil film, however, does not imply that there will be no pitting. As you have reported, the actual contact fatigue strength of high speed gears is much higher than the computed contact stress. This does not mean that Hertz equation is incorrect but rather indicates that one should consider elastic fluid lubrication theory. Since Hertz equation does not take into account the oil film between the contact surfaces, solutions should be sought using Reynolds equation, viscosity equation together with Hertz equation. Such calculations can be easily done with a computer. For practical convenience we may also consider using qualitative index such as wp^3 as a threshold value for the existence of oil film. At the moment this value is of course undetermined and more data needs to be accumulated.

One might wonder how can the oil film exist between the tooth faces at such high pressures without being squeezed out. In the past, intersecting pattern marks exist on tooth faces of gears made on Maag gear grinding machines and such machine marks remain after extended use of some high speed light load gears. This puzzled people for almost 40 years before it was realized that oil films do exist and the theory of elastic fluid lubrication was established. At present, however, studies of the parameters and conditions for film formation are still very scanty and we cannot be sure that wp^3 is the relevant factor. But we do believe that in high speed transmission the circular arc gears can be used at linear velocities greater than 80 m/sec without taking too much risk. This is because the higher the velocity the easier it is to form oil film and the better the pitting resistance. Bench tests of the real objects are relatively difficult and costly. It can only be done together with product tests.

Can oil films be formed at lower speed? This would not be possible using ordinary lubricating oil. DuPont Company in the United States produces a lubricant known as synthetic hydrocarbon that has the property of a greatly increased viscosity at the slight increase of pressure. It has been successfully used in rolling bearings in the early 1970's. In 1975 DuPont conducted a joint experiment with Ford Motor Company in which friction drive was used to replace gear drive in automobile transmission case. This change enabled a good match between the internal and external characteristics of the engine and resulted in improved acceleration, power and fuel economy and reduced urban air pollution as well. Since this type of transmission appears to have good competitive power, we should also carry out research on this lubricant.

III. Gear Noise

The noise problem is receiving wide attention today. It is now hard to say which is noisier, the single circular arc or the double circular arc gear, but it is safe to say that they are both noisier than well-machine involute gears. There are different assessments on this problem, but my personal assessment is that the noise problem has very much to do with the tolerance of the lead screw of the gear hobbing machine. Because the lead screw tolerance does not have as great an effort as the accuracy of the workbench divider in the case of involute gears, the machine tool industry did not put too much effort into it in the past. For circular arc gears, however, the effect of the helix tolerance is comparable to that of the tooth profile tolerance of involute gears when the coincidence coefficient is close to 1. At present the precision of grinding involute gears is 3-4 μ , whereas 20 μ error may exist in the helical line of hobbed gear of 300 mm width, so the noise is greater.

I submit that the accuracy of lead screws in gear hobbing machines should be improved to suit the manufacture of circular arc gears. The accuracy of the feeding lead screw should be comparable to that of the lead screws in screw grinding machines and that is not hard to achieve.

In order to reduce wear, static pressure screw nut should be used. Shanghai Machine Tool Plant No 2 has tried static pressure screw nuts on 10 of their precision lead screw lathes and so did several other machine tool plants. There are no particular difficulties in doing so and it will not increase the costs. The strength of the tool block should also be improved and thicker arbors should be used in reducing the very high frequency noise and the cutter ripples. In addition, since shaping is used for high speed involute gear, it should also be done for circular arc gears in their helical direction as this may also affect the noise property.

The manufacture of gear cutters is not a simple matter. The manufacture of hobbing cutters for circular arc gears is much more difficult than that for involute gears. The precision standard for involute gear hobs is still used for the tolerances of hobs for circular arc gears. Actually there should be some differentiation on certain items. For example, for involute gear hob the tooth pitch error will show up as errors in the base pitch and the tooth profile of the gears, so the requirements are very stringent. For circular arc gears, the tooth pitch error does not have as great an effect. For double circular arc gears, however, the height of the center of the two circular arcs of the gear hob does indeed affect the performance of the circular arc gears and the requirement on it should be somewhat higher. Therefore, inspection methods for hob tolerance and profile center constitute an urgent task for the future.

We should also investigate what criteria should be used for gear failure, especially for pitting. Broken teeth are of course very simple. Some early stage pitting appears to have occurred in the weaker and defective spot of the material and gear failure is caused by maximum shear stress. But in the course of running fit and cold work hardening, fitting may not develop and may even disappear. So the question of what kind of pitting should be considered as contact fatigue damage still needs more careful study.

As for directions for future work, in addition to the ones mentioned above, such as designing gears from the point of view of elastic fluid dynamic lubrication theory, investigation of the viscosity of lubricating oil and lubricants, and technology for noise reduction, there are other items needed in the production. These items can be theoretical or practical and they require both intelligence and skill. For instance, the manufacture of gear hob is primarily a skill problem.

I doubt that the gear contact problem is actually a lubrication problem. I did not originate this idea. It has long been proposed in the science of friction. I would therefore hope that experts in gear research and experts in lubrication will work together to solve these topics.

(Note: Section titles are the editor's)

9698

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SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

CHINESE AERONAUTICAL INSTITUTES OF HIGHER LEARNING LISTED

Beijing HANGKONG ZHISHI [AEROSPACE KNOWLEDGE MAGAZINE] in Chinese No 5, May 81
pp 2-3

[Article by the Third Ministry of Machine Building]

[Text] Under the jurisdiction of the Third Ministry of Machine Building are three key universities: the Beijing Aeronautical Institute, the Northwest Industrial University, and the Nanjing Aeronautical Institute; and three regular universities: the Shenyang Aero-Industrial College, the Nanchang Aero-Industrial College, and the Zhengzhou Aero-Industrial Management School. In 1981, these schools participated in the nation-wide recruiting campaign to solicit students from 25 provinces, municipalities, and autonomous regions. Aeronautical higher institutions are multi-discipline institutions with primary emphasis on aeronautical science; their objective is to develop moral character as well as the intellectual and physical abilities of advanced engineering and scientific talents. After graduation the students are generally assigned to work as scientists or engineers in research, design, or production organizations in the aeronautical industry or to teach in higher institutions.

For the benefit of our readers and students wishing to enter aeronautical institutions, this article summarized below the specializations offered, the curriculum and goals, as well as the quota of new students for each institution for the 1981 academic year.

Beijing Aeronautical Institute
(address: Beijing City)

The Beijing Aeronautical Institute is the first integrated university of aeronautical engineering and scientific technology established after the liberation. It is currently being developed into a center for both education and research. The institute has eight departments and two basic curriculum sections which are divided into 12 academic disciplines and with 30 specializations. In addition, there are four research offices, six special research groups, an electronic computer center, and 45 laboratories. Currently, the Institute employs 39 professors, 166 assistant professors, and 1175 instructors.

In 1981 the Beijing Aeronautical Institute is accepting applications from 25 provinces, municipalities, and autonomous regions for the following openings: 850

regular 4-year students, and 170 graduate students studying for their Masters or Doctors degrees. The specializations offered this year include:

1. In the flying vehicle category: airplane design, winged missile design, and airplane high altitude equipment;
2. In the jet propulsion category: turbine engines and rocket engines;
3. In the aero-mechanical manufacturing category: mechanical manufacturing, production automatic control, airplane manufacturing, plastic engineering, and welding engineering;
4. In the material science and material engineering category: aeronautical metal science and engineering, polymer composite material engineering, metal corrosion science and protection engineering;
5. In the automatic control category: flying vehicle automatic control, gyroscopic equipment and inertial guidance, and aero-electrical engineering;
6. In the fluid control engineering category: fluid control and operational system;
7. In the computer science and engineering category: electronic computers, and computer software;
8. In the aeronautical radio engineering category: radio remote control and telemetry, radar and navigation, microwave technology and antenna;
9. In the engineering mechanics category: flight mechanics, aerodynamics, and solid mechanics;

Northwest Industrial University
(address: Xi'an City)

The Northwest Industrial University is a multi-discipline technical university with specialization in aeronautics. It is now being developed into a school which serves as a center for both education and research. The University has eight departments and a basic curriculum section that offer 33 different specializations. In addition, there are 12 research offices, a computer center, and 49 laboratories, part of which are under construction. Currently, the University faculty consists of 37 professors, 135 assistant professors, and 853 instructors.

In 1981, the Northwest Industrial University is accepting applications from 21 provinces, municipalities, and autonomous regions for the following openings: 780 regular students (4-year program), and 130 graduate students who are candidates for Masters or Doctors degrees. The specializations offered this year include the following:

1. In the Airplane Department: airplane design, aerodynamics, and airplane structural mechanics and strength of materials;

2. In the Aircraft Engine Department: aircraft engines;
3. In the Space Engineering Department: rocket engine, and automatic control for missiles;
4. In the Ship Instrumentation Department: non-trigger torpedo fusing, torpedo automatic control;
5. In the Aircraft Electronic Engineering Department: electronic computers, computer software, radar, radio technology, and fire control;
6. In the Aircraft Automatic Control Department: gyroscope and inertial navigation, automatic control airplanes, and aero-electrical engineering;
7. In the Aircraft Production Engineering Department: airplane production engineering, and aero-mechanical production engineering;
8. In the Material Science and Engineering Department: metal and heat treatment engineering, non-metallic material science and engineering, forging technology, casting technology, and welding technology;
9. In the Basic Curriculum Section: applied mathematics, and general mechanics.

Nanjing Aeronautical Institute
(address: Nanjing City)

The Nanjing Aeronautical Institute is an aeronautical engineering and technical university which is also being established as a center for education and research. The school has six departments and a basic curriculum section with 17 different specializations. In addition there are five research offices, and more than 40 laboratories. The faculty currently consists of 19 professors, 36 assistant professors, and 675 instructors.

In 1981 the Nanjing Aeronautical Institute is accepting applications from 21 provinces, municipalities, and autonomous regions for 600 regular students (4-year program) and 100 graduate students. The specializations offered include the following:

1. In the Airplane Department: helicopter design, and high altitude equipment;
2. In the Aircraft Engine Department: turbine engine, and power plant control engineering;
3. In the Aircraft Automatic Control Department: flying vehicle automatic control, gyroscope and inertial navigation, aircraft instrumentation and sensors, and aero-electrical engineering;
4. In the Aeronautical Radio Department: electronic computers, radar and electronic countermeasures, and radio communication;
5. In the Aircraft Production Engineering Department: mechanical production system engineering, mechanical automatic control engineering, and airplane production engineering;

6. In the Aerodynamics Department: aerodynamics.

Shengyang Aero-Industrial College
(address: Shengyang City)

The Shengyang Aero-Industrial College is an institution for training advanced technical talents in the aeronautical industry. The College has three departments with six specializations, and 25 laboratories. The College is well known for its cold finishing technology which is urgently needed by various production and research organizations. Currently the school has 1500 faculty members and employees, and 1000 students.

In 1981 the College is recruiting 300 students from 13 provinces, municipalities, and autonomous regions. The specializations being offered include the following:

1. In the Aeronautical Engineering Department: aircraft engines, and airplane production;
2. In the Mechanical Engineering Department: aero-mechanical finishing technology, mechanical equipment design and production;

In the Electronic Engineering Department: electronic computers technology and applications.

Nanchang Aero-Industrial College
(address: Nanchang City)

The Nanchang Aero-Industrial College is a 4-year institution for training advanced engineering and technical personnel in the aeronautical industry. The College has four departments, seven specializations, and 30 laboratories. It enjoys a good reputation in aeronautical heat finishing technology, which has been well received by production and research organizations. Currently the school has 1,500 faculty members and employees, and more than 1,200 students.

In 1981 the College is recruiting 150 students from 12 provinces, municipalities, and autonomous regions. The specializations being offered this year include the following:

1. In the Aeronautical Heat Finishing Department: casting technology, metals and heat treatment technology;
2. In the Aero-Chemical Engineering Department: aircraft material and protection;
3. In the Aero-Mechanical Engineering Department: aero-mechanical finishing technology.

Zhengzhou Aero-Industrial Management School
(address: Zhengzhou City)

The Zhengzhou Aero-Industrial Management School is a 3-year school for training personnel in industrial management and engineering.

The school has four departments and four specializations. With current emphasis on improving management standards, this school plays a particularly urgent and important role in developing managers in the aeronautical industry. Currently the school has more than 1,000 faculty members and employees, and nearly 1,000 students.

In 1981 the school is recruiting 200 students from 12 provinces, municipalities, and autonomous regions. The specializations being offered this year include the following:

1. In the Financial Management Department: industrial accounting;
2. In the Organizational Management Department: management planning;
3. In the Material Management Department: material management;
4. In the Technical Document Management Department: scientific and technical document management.

Appendix 1981 Student Recruiting Plan for Vocational Universities Under the Third Ministry of Machine Building

School	Subtotal	Shaanxi	Gansu	Yunnan	Guangxi	Chongqing	Inner Mongolia	Locality
Total number of students recruited by Higher Institutions belonging to the Third Ministry of Machine Building								
Beijing Aerometrical Institute	100	30	10	10	25	10	25	175
Northwest Industrial University	700	65	20	20	20	25	20	20
Beijing Aerometrical Institute	600	20	20	20	20	20	20	20
Chongqing Aero-Industrial College	300	20	20	20	20	20	20	20
Wenzhong Aero-Industrial College	150	10	20	10	20	20	20	20
Zhongtian Aero-Industrial Management School	200	20	20	20	20	20	20	20

Table I	Russia	Central	Eastern	Southern	Western	Northern	Central	Eastern	Western	Northern
160	10	25	15	10	10	10	10	10	10	10
150	20	20	20	20	20	20	10	10	10	10
140	45	25	25	20	20	20	10	10	10	10
130	65	25	25	20	20	20	10	10	10	10
120	85	25	25	20	20	20	10	10	10	10
110	105	25	25	20	20	20	10	10	10	10
100	125	25	25	20	20	20	10	10	10	10
90	145	25	25	20	20	20	10	10	10	10
80	165	25	25	20	20	20	10	10	10	10
70	185	25	25	20	20	20	10	10	10	10
60	205	25	25	20	20	20	10	10	10	10
50	225	25	25	20	20	20	10	10	10	10
40	245	25	25	20	20	20	10	10	10	10
30	265	25	25	20	20	20	10	10	10	10
20	285	25	25	20	20	20	10	10	10	10
10	305	25	25	20	20	20	10	10	10	10
0	325	25	25	20	20	20	10	10	10	10

Tianjin	Beidaihe	Shuangfeng	Beijingshi	Liaoning	Jilin	Heilongjiang
40	95	65	35	195	80	130
20	30	30	15	50	30	40
10	20	20	20	25	15	20
15	15	15	15	20	15	20
				20	20	30
					10	10
						10

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Environmental Science

AUTHOR: WANG Lijun [3769 4539 6511]
ZHANG Shen [4545 3947]

ORG: Both of Institute of Geography, Chinese Academy of Sciences

TITLE: "Studies on Method of Separation and Concentration of Trace Cr II and Cr VI in Water With Ionexchange Resins"

SOURCE: Beijing HUANJING KEXUE [ENVIRONMENTAL SCIENCE] in Chinese Vol 2 No 2, 30 Apr 81 pp 4-11

ABSTRACT: Ionexchange method is applied to separate, concentrate, and precisely determine the ppb quantity of Cr III and Cr VI in water. The water sample is continuously, in the form of reverse flow, fed through a negative (No 717, SO₄²⁻ type) and positive (No 732, H⁺ type) resin columns to cause Cr VI and Cr III to be exchanged in the lowest layer of the negative and positive columns respectively before being flushed separately. A small volume of reducing acid solution is added to the negative column to reduce the CrO₄²⁻ into Cr III and to be quickly washed off. On the positive column, only a small amount of acid solution is needed to completely wash off Cr III. The Cr content in the reclaimed solution is determined with DPC colorimetric method. This method is proved by the official Cr III and Cr VI reclaiming experiment to be suitable for separation and determination of chromium of different valences in environmental specimens.

AUTHOR: LI Yuxian [2621 7183 0103]
WANG Guoming [3769 0948 2494]
YAN Huiyu [0917 6541 1342]

ORG: All of Institute of Environmental Chemistry, Chinese Academy of Sciences

TITLE: "Determination of Phenols by Direct Amperometric Method"

SOURCE: Beijing HUANJING KEXUE [ENVIRONMENTAL SCIENCE] in Chinese Vol 2 No 2, 30 Apr 81 pp 11-15

ABSTRACT: This paper proposes a new method of determining phenols--the amperometric method [the direct electric current method]. Gold is used as the working electrode and silver-silver chloride the control electrode (the reference electrode as well). In solutions of 0.07M Na₂B₄O₇ and 0.14M KCl, when permanent voltage of 650mV is added, the current produced by oxidation of phenol on the gold electrode is in direct proportion to the phenol content of the solution. This method is simple and easy. It was used to determine the total phenol content in the coking waste water with satisfactory results.

AUTHOR: QIAN Jun [6929 6511]
GUO Sujuan [6751 4790 1227]

ORG: QIAN of Shanghai Institute of Nuclear Energy, Chinese Academy of Sciences;
GUO of Shanghai Changzheng Electroplating Plant

TITLE: "Research on Purification of Electroplating Wastewater Containing Chromate by Electrodialysis"

SOURCE: Beijing HUANJING KEXUE [ENVIRONMENTAL SCIENCE] in Chinese Vol 2 No 2,
30 Apr 81 pp 16-21

ABSTRACT: This paper introduces the experimental electrodialysis method of purifying electroplating wastewater using polyfluoroethylpropene negative ionexchange film (F_{46} negative film) and polytrifluo-benzene ethylene positive ionexchange film (SF-1 positive film) to make the electrodialysis instrument. It can cause wastewater containing 75mg/l of Cr VI to be purified to 0.4mg/L. The experiment demonstrates that F_{46} negative film and SF-1 positive film have a relatively long useful life and are also resistant to oxidation of heavy chromic acid.

AUTHOR: YE Changming [0673 1603 2494]
XIE Yongming [6200 3057 2494]
DU Xiuying [2659 4423 5391]
MA Ruixia [7456 3843 7209]

ORG: All of Institute of Environmental Chemistry, Chinese Academy of Sciences

TITLE: "Studies on Parameters Estimation of Stream Water Quality"

SOURCE: Beijing HUANJING KEXUE [ENVIRONMENTAL SCIENCE] in Chinese Vol 2 No 2,
30 Apr 81 pp 21-26

ABSTRACT: This paper is a comprehensive discussion of several different methods of parameter estimation of mathematical models of stream water quality. Combined with the authors' research of water quality mathematical model of Lijiang in Guilin District of Guangxi, the parameters of the various methods are compared. The various factors affecting the parameter estimation value are analyzed and the self-cleaning coefficient of 3 sections in Lijiang river is computed. Finally, the various parameters are used in the oxygen balance model to compute the density of the dissolution oxygen and the computed value is compared with the experimental value to discover a relative uniformity between the two.

AUTHOR: LIU Wanjun [0491 8001 6511]
ZHAO Guoshen [6392 0948 3791]

ORG: Both of Liaoning Provincial Institute of Meteorological Sciences

TITLE: "Structure of Meteorological Elements Field and Air Pollution in Shenyang"

SOURCE: Beijing HUANJING KEXUE [ENVIRONMENTAL SCIENCE] in Chinese Vol 2 No 2,
30 Apr 81 pp 26-31, 60

ABSTRACT: This paper presents a preliminary analysis of the city's temperature field, wind field, and humidity field variations caused by the presence of a heat island. Combined with the continuously monitored data of SO₂ density, the meteorological conditions affecting the atmospheric pollution of Shenyang are also analyzed.

AUTHOR: HU Sicai [5170 3128 2088]

ORG: Department of Biology, Jiangxi University

TITLE: "The Toxicity of Rare Earth Nitrate to Daphnia Carinata King"

SOURCE: Beijing HUANJING KEXUE [ENVIRONMENTAL SCIENCE] in Chinese Vol 2 No 2,
30 Apr 81 pp 32-35

ABSTRACT: In the most recent decade, rare earth elements have been extensively applied and since 1972 more than 60 reports have been published in China to verify the yield increase effect of rare earth fertilizer, mainly rare earth nitrate, on various crops. Research is, therefore, urgently needed to determine the effect of these elements on men, animals, and other organisms. This paper reports some experiments to test and observe the effects of rare earth nitrate on the reproductive ability, the survival rate, and the life span of water fleas (*Daphnia carinata King*) which are an important feed of fishes. The result proves that within the density range of 0.390 mg/l, rare earth nitrate does not have adverse effect on the fleas. The test specimens are obtained from Qingshan Lake, the major water of the suburb of Nanchang City, Jiangxi Province.

AUTHOR: ZHENG Haoming [6774 7729 7686]
WANG Houji [3076 0624 1015]

ORG: Both of Shanghai Institute of Metallurgy, Chinese Academy of Sciences

TITLE: "Application of Piezoelectric Quartz Crystal to the Determination of SO₂ in Atmosphere"

SOURCE: Beijing HUANJING KEXUE [ENVIRONMENTAL SCIENCE] in Chinese Vol 2 No 2,
30 Apr 81 pp 35-38

ABSTRACT: This paper reports experiments with piezoelectric quartz crystal resonance instrument to determine atmospheric SO₂. Semi-finished commercial AT, 9MHz quartz crystal chip is covered with a layer of gold in a vacuum filming instrument to form the piezoelectric electrode before using it to make the resonance instrument to proceed with experiments with respect to such aspects as the frequency, the temperature, the volatilization of TEA, and the elimination of interference. The experimental system and the results are discussed.

AUTHOR: XIANG Qixiang [7300 0366 4382]
MIN Weizong [7036 5588 1350]
YU Xingguang [0151 5281 0342]
YUAN Hongying [5913 4767 2937]

ORG: All of Department of Chemistry, Sichuan University

TITLE: "Determination of Uranium in Sea Water"

SOURCE: Beijing HUANJING KEXUE [ENVIRONMENTAL SCIENCE] in Chinese Vol 2 No 2,
30 Apr 81 pp 39-41

ABSTRACT: Alkali magnesium carbonate is used as the precipitating agent to absorb and concentrate trace uranium in sea water. When the density of the uranium content is 3.00-7.00 μ g/l, the rate of return is above 95 percent, the varying coefficient is only 4 percent. The minimum uranium content for the test is 1.00 μ g/l.

AUTHOR: ZHENG Rongliang [6774 2837 2733]
DONG Jinting [5576 6855 1694]
LIU Peiqi [0491 1173 3825]
WANG Xiaoxuan [3769 5135 5503]
ZHOU Xiufang [0719 4423 5364]

ORG: All of Teaching and Research Office of Biophysics, Lanzhou University

TITLE: "The Concentration of Free Radicals in the Air of Lanzhou"

SOURCE: Beijing HUANJING KEXUE [ENVIRONMENTAL SCIENCE] in Chinese Vol 2 No 2,
30 Apr 81 pp 42-43

ABSTRACT: ESR signals are obtained from the air samples of all 8₃ test points. The density of stable free radicals of these points averages 139 mm/m³ in the winter, 69 mm/m³ in the spring, 34 mm/m³ in the summer, and 39 mm/m³ in the autumn. The density of free radicals in the atmosphere of areas of better afforestation, fewer factories, and with no heavy traffic channels, and remote suburban villages is lower. Within the period of one day, the density varies in the atmosphere of the same point: 59.5 at 8 a.m., 61 at 11 a.m., 31.5 at 8 p.m., 28.4 at 2 p.m. 24.2 at 5 p.m., 27.7 at 11 p.m., and 11.1 at 2 a.m.

AUTHOR: WANG Jiebiao [3769 7132 2871]
HU Zhifen [5170 1807 5358]
GUO Jinxing [6751 6855 2502]

ORG: All of Tangshan Municipal Public Health and Epidemic Prevention Station

TITLE: "Investigation of the Accumulation of 666, DDT, in the Human Body in Tangshan"

SOURCE: Beijing HUANJING KEXUE [ENVIRONMENTAL SCIENCE] in Chinese Vol 2 No 2,
30 Apr 81 pp 44-46

ABSTRACT: At present, 666 and DDT are the most frequently used organic insecticides in China. After the earthquake, they have also been used in Tangshan as disinfectants to prevent epidemics. They are stable chemicals and will remain as environmental pollutants for a long time. Surveys of water and food indicate various degrees of contamination in the city. Due to the fact that they are highly dissoluble in fats and have a relatively high affinity to enzymes and proteins, it is difficult to expel them from the body. Fat specimens of hypodermic, mesenteric, etc. areas are collected from 75 male and 164 female cases of various hospitals in the city and 96 cases of nearby rural villages for petroleum ether extraction. The SP-2305E gaseous chromatograph with an electron capturing device is used to determine the 666, DDT contents. Organic chlorine was found in all specimens, averaging 14.70ppm: 9.22 ppm of 666, and 5.48 ppm of DDT. Details are reported.

AUTHOR: XU Junqu [6079 1327 2575]
LI Jimei [4151 4949 5019]
WANG Gong [3769 3827]

ORG: All of Jiangxi College of Metallurgy

TITLE: "Studies on Purification of Dyeing Wastewater by Magnetic Fluid"

SOURCE: Beijing HUANJING KEXUE [ENVIRONMENTAL SCIENCE] in Chinese Vol 2 No 2,
20 Apr 81 pp 46-49

ABSTRACT: Wastewater of printing dyeing, especially that of sulfide dyes, is difficult to treat and all existing methods, which are many, have a shortcoming of producing secondary residues. The ferric oxide-magnetic fluid technique is new. This paper explains the theory of this new technique and reports an experiment designed to test its effectiveness. The result indicates that after purification the wastewater meets the standard requirement for discharge while the secondary residue is also transformed into a special material, the magnetic fluid. This technique is therefore, judged to be promising, being less costly and more efficient than other available techniques.

AUTHOR: LIU Xia [0491 0204]

ORG: Aerial Remote Sensing Geology Team, Hunan Provincial Bureau of Geology

TITLE: "Applications of Aerial Infrared Scan Technique for Thermal Pollution Survey"

SOURCE: Beijing HUANJING KEXUE [ENVIRONMENTAL SCIENCE] in Chinese Vol 2 No 2,
20 Apr 81 pp 48-49

ABSTRACT: Source of heat pollution is different from its surrounding environment in a temperature differential of several, several tens, to several hundred degrees. The infrared energy emission of an object, according to Stefan-Boltzmann Law, is in direct proportion to the fourth-power of its absolute temperature; therefore, the difference should be very obvious. In 1978, the team, in cooperation with related organisations, carried out an experiment to test the effectiveness of the aerial infrared scan technique in detecting thermal pollution. The test areas included Changsha, Zhuzhou, Xiangtan, etc. of Hunan Province. The technique, the experimental procedure, and the resultant data are reported.

AUTHOR: ZHAO Dianwu [6392 3013 0063]
MOU Shifan [3664 0013 5358]
CHEN Letian [7115 2867 1815]
LIU Kena [0491 0344 4780]

ORG: All of Institute of Environmental Chemistry, Chinese Academy of Sciences

TITLE: "Investigation of Acidity of Rainwater in Beijing During Summer of 1980"

SOURCE: Beijing HUANJING KEXUE [ENVIRONMENTAL SCIENCE] in Chinese Vol No 2,
30 Apr 81 pp 50-54

ABSTRACT: In recent years, acid rain has attracted a great deal of attention. For the purpose of proceeding with a preliminary investigation of the problem of acid rain under the concrete condition of North China, the authors gathered snow and rainwater specimens from several points in Beijing in the winter of 1979-80 and the summer of 1980 for analyses. The pH value of the precipitation specimens was found to be 6-7 in 29 specimens, amounting to 74 percent; 5.5-7 in 37 specimens, amounting to 94 percent. These values are similar to test results of Aug 73 and May 74. The SO₂ level of the winter is about 3 times that of the summer, but the pH of the snow is close to that of the summer rain. In view of these findings, the precipitation of Beijing at present is nearly neutral.

AUTHOR: JIANG Yanyin [3008 4282 0936]
WANG Suyun [3769 4790 5366]
CHEN Huizua [7115 1920 5478]
YANG Chunlin [2799 2504 2651]
QIAN Hua [6929 5478]

ORG: All of Shanghai Municipal Institute of Environmental Protection Sciences

TITLE: "Determination of Acidity and Some Ion Contents of Rainwater in Shanghai"

SOURCE: Beijing HUANJING KEXUE [ENVIRONMENTAL SCIENCE] in Chinese Vol 2 No 2,
30 Apr 81 pp 54-56

ABSTRACT: The acid rain phenomenon has occurred in a number of areas of the world as a result of atmospheric discharge of pollutants in recent years. It has been discovered in Chongqing area of China, but aside from the region of Beijing there have not been tests in most other areas. Beginning in Mar 80, the authors have carried out pH tests and chemical analyses of rainwater from points of Yangtshpu District, an area of heavy concentration of industries and of Lujiazui District, an area of relatively fewer industries. This paper reports the results of observations during the period of Mar-Aug 80. The experimental method and results are reported..

AUTHOR: LYU Chunyuan [0712 2504 0337]

ORG: Guangdong Provincial Institute of Pedology

TITLE: "A Preliminary Research on Cd Contamination of Soil and Crop and Its Control"

SOURCE: Beijing HUANJING KEXUE [ENVIRONMENTAL SCIENCE] in Chinese Vol 2 No 2,
30 Apr 81 pp 57-60

ABSTRACT: Not a few scientists believe that after cadmium enters the soil, it concentrates mainly in the surface layer and does not move very much, while the Cd content of crops does not coincide with the Cd content of the soil. It appears that grain crops absorb less Cd and leafy vegetables more. For the purpose of clarifying the Cd fixing process of soil of dry fields, the Cd absorption of crops, and finding easily implemented measures to improve the ability of soil to fix Cd, an experiment was carried out in 1977-79. Based upon the results, the relationship between soil Cd contents and the growth of crops, the Cd absorption of crops, Cd fixing of soil and additives, and the variation of active Cd in the plow layer of soil are discussed.

AUTHOR: CAO Hongfa [2580 3163 3127]

ORG: China Research Academy of Environmental Sciences

TITLE: "Pollution of Heavy Metals in Ecosystem"

SOURCE: Beijing HUANJING KEXUE [ENVIRONMENTAL SCIENCE] in Chinese Vol 2 No 2,
30 Apr 81 pp 61-64

ABSTRACT: Heavy metal pollutants remain stable in the environment and are very toxic for living things. When they are concentrated in the food chain, the potential harm to men is also very great. Based upon recent foreign and domestic studies, this paper discusses the accumulation, transfer, and cycling of heavy metals in the ecosystem, the toxic physiological reaction of plants to toxicity of heavy metals, characteristics of heavy metal polluted soils, effects of heavy metals on the structural functions of the ecosystem.

AUTHOR: WANG Shusen [3769 2885 2773]

ORG: Environmental Protection Research Office, Beijing Industrial University

TITLE: "Molecular Design of RO Membrane Materials for Treatment of Wastewater Containing Chromic Ions"

SOURCE: Beijing HUANJING KEXUE [ENVIRONMENTAL SCIENCE] in Chinese Vol 2 No 2, 30 Apr 81 pp 64-70

ABSTRACT: Since the discovery by Loeb and Sourirajan of the high flow volume acetate cellulose membrane, there has been considerable progress in the research on this new type of reverse osmosis membrane materials and their use for the treatment of industrial wastewater, especially electroplating wastewater. These membranes have several structures, which are closely related to the properties and functions of the membranes. For the purpose of determining the ideal structure for treating wastewater containing chromic ions so that one with such a structure may be found among those available on the market or one may be synthesized to meet such a structural requirement, this paper discusses at length the effect of the membrane structure on its property in its various aspects.

AUTHOR: LIU Duosen [0491 1122 2773]

ORG: Nanjing Institute of Pedology, Chinese Academy of Sciences

TITLE: "Second Report on the Calculation of Environmental Quality Value"

SOURCE: Beijing HUANJING KEXUE [ENVIRONMENTAL SCIENCE] in Chinese Vol 2 No 2, 30 Apr 81 pp 71-73

ABSTRACT: With the rapid advancement in computer science, polynomial analysis techniques have also been developing very fast. Theoretically, these techniques are very well established. Their application in environmental science, especially in the evaluation of environmental quality, is very promising. A branch of the polynomial analysis, the major component analysis, may be used to distinguish the type of pollutants and their corresponding pollution process; therefore, it may also be used for the classification of environmental quality. In the summer of 1978, on the basis of reviewing several ways of expressing environmental quality, frequently adopted at present, the author proposed an equation for computing the quality of a given environment A_1 . This paper is a continued discussion of the linear algebraic meaning and the biological meaning of the A_1 value [Quality] as it is expressed in the equation.

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Vacuum

AUTHOR: CAI Shuming [5591 2885 6900]

ORG: Tieling Institute of Rubber Research

TITLE: "Selection and Application of Vacuum Seal Rubber"

SOURCE: Shenyang ZHENKONG [VACUUM] in Chinese No 1, 81 pp 16-20

ABSTRACT: Vacuum technology is now being applied in many industries and in order to promote its continuous advancement, vacuum seals must be continuously improved. At present, rubber seals can meet the requirement of 10^{-9} - 10^{-10} torr of supervacuum. Aside from a correct and precise design of the structure, a reasonable selection of an elastic material is the key to a satisfactory vacuum seal. Major factors influencing the sealing quality of the rubber materials, including heat resistance, compression resistance, air leak rate, gas permeability, sublimation, are discussed. Various rubber materials are compared in terms of these factors. Finally, a principle for designing vacuum seal rubber material, involving a selection of raw resin, determination of the sulfide system, the reinforcing agent, and the plasticizer, is proposed.

AUTHOR: CHEN Degui [7115 1795 6311]

ORG: None

TITLE: "Make-it-Yourself High Vacuum Ionization Vacuum Gage Circuit Calibrator"

SOURCE: Shenyang ZHENKONG [VACUUM] in Chinese No 1, 81 pp 37-40

ABSTRACT: Triode type hot cathode ionization vacuum meter is an instrument in extensive use, with its theory and structure, etc. designed to measure in the range of 10^{-4} - 10^{-7} torr, the requirement of the electron tube industry. The quality of this instrument directly affects the quality of the electron tubes produced by the plant. It is, therefore, necessary to test the various parameters, to adjust the ion beam, etc. through the use of some highly precise instruments, including small current meter capable of testing 0.1 microampere, a high resistance D.C. bridge, a high precision voltmeter, etc. which many plants do not have. Through repeated experimentation and revision, the author and colleagues finally made the ionization meter circuit calibrator for this purpose. The design has been certified by Jiangsu Provincial Bureau of Measurement Standards. The theory, structure, and processes of application are described.

AUTHOR: CHEN Wenkui [7115 2429 1145]

ORG: Institute of Nuclear Energy

TITLE: "Reverse Flow Helium Mass Spectrometric Leak Detection Technique"

SOURCE: Shenyang ZHENKONG [VACUUM] in Chinese No 1, 81 pp 45-47, 44

ABSTRACT: With ordinary helium mass spectrometric leak detector, the gas of the tested article passes through a flow regulating valve into the spectrometric chamber to be analyzed. In case of reverse flow helium mass spectrometer, the gas passes through the valve to enter a first stage diffusion pump of the detector to be reversed before entering the spectrometric chamber. With the ordinary detector, liquid nitrogen is needed to capture vapor or steam coming from the tested article which may not be sufficiently dried and cleaned to prevent it from contaminating the spectrometric chamber. This is not necessary with the reverse flow leak detector, even when the tested article leaks a great deal and is not highly clean. With drawings depicting the reverse flow helium mass spectrometric leak detector, the paper explains its merits and compares its various properties with the ordinary leak detector.

AUTHOR: XING Jun [6717 6511]

ORG: None

TITLE: "Boshan Vacuum Pump Plant Succeeded in Making the QBY-40 Oil Lubricated Chute Blade Style Vacuum Pressure Compound Air Pump"

SOURCE: Shenyang ZHENKONG [VACUUM] in Chinese No 1, 81 p 79

ABSTRACT: The QBY-40 oil lubricated chute blade style vacuum pressure compound air pump can produce a vacuum and blow compressed air simultaneously. It is a piece of indispensable auxiliary equipment for modern printing and binding machines. Its blades are made of thin sheets of steel and it is equipped with a minute quantity oil pump for forced lubrication. A load relief ring is used so that the rotating blades do not have direct contact with the cylinder. There is also a suitable device to absorb the air and to separate oil and air. The various properties of the pump have been certified by a certification conference held 27-28 Dec 80 in Boshan of Shandong Province and it will soon be produced in batches.

AUTHOR: SHI Deyuan [4258 1795 0337]

ORG: Color Metals Research Academy, Ministry of Metallurgical Industry

TITLE: "Using Vacuum Cathode Plasma Beam to Smelt Rare and Difficult to Melt Metals"

SOURCE: Shenyang ZHENKONG [VACUUM] in Chinese No 2, 81 pp 1-4, 47

ABSTRACT: Following a brief review of the history of metallurgy of rare and difficult to melt metals and their alloys, this paper explains the basic theory of the vacuum cathode plasma beam smelting technology, which made its appearance in the 1960's. Using plasma beam as the heat source, smelting is done in argon vacuum. Results of smelting titanium, zirconium, niobium, molybdenum, and tantalum using the 120KW plasma beam smelting furnace (the manufacturer of the furnace is not named.) are given in a table. Finally, under the heading of condition of research and development a Japanese make plasma beam smelting furnace using 6 vacuum cathodes to achieve a power of 2400KW and an electromagnetic method of deflecting and scanning the plasma beam created by the author and colleagues are very briefly mentioned.

AUTHOR: LIU Renjia [0491 0088 1367]

ORG: Capital Machinery Plant

TITLE: "Characteristics of the ZG-65 Vacuum Quenching Furnace"

SOURCE: Shenyang ZHENKONG [VACUUM] in Chinese No 2, 81 pp 5-7

ABSTRACT: In Jan 80, the Capital Machinery Plant succeeded in making the vacuum heat treatment furnace, using graphite cloth and refractory fiber insulation for oil quenching and air cooling. Its major characteristics are described as follows: (1) The major metal components are made of carbon steel, with none or very little precious or rare metal materials. (2) New type of heating and insulating materials are adopted. The graphite and refractory fiber cushion insulation is 40 mm in thickness and inside the furnace, 6 pieces of superior quality electrode graphite cloth are used as heating elements. (3) An oil motor is used in the place of the electrical motor to simplify the structure, to realize no-stage regulation of speed, and to eliminate or reduce dynamic seals so as to lessen the chance of a vacuum leak. Drawings are given to help explain the properties and characteristics of the quenching furnace.

AUTHOR: WANG Yanxun [3769 1693 8113]

ORG: Beijing Scientific Instrument Plant, Chinese Academy of Sciences

TITLE: "Concerning Frequency Modulation Starting of Turbine Molecular Pump and the Work Characteristic of the Special Use Power Source for the FB Type Molecular Pump"

SOURCE: Shenyang ZHENKONG [VACUUM] in Chinese No 2, 81 pp 8-14, 40

ABSTRACT: In recent years, great accomplishments have been achieved in China with respect to experimenting and producing vertical stype turbine molecular pumps. If a molecular pump is to have a satisfactory property, aside from careful designing and making the pump, a special electrical power source is also needed to guarantee stable operation of the molecular pump. The special power source must be capable of providing the asynchronous motor a speed regulating, frequency modulating₁₀ and voltage adjusting requirement, so that under a vacuum condition of 10^{-2} - 10^{-10} torr, a high speed rotation of 24,000/min may be accomplished. Various problems relating to all aspects of this special electrical power source and their solutions are discussed.

AUTHOR: SHEN Gonglie [3947 0501 3525]

ORG: None

TITLE: "Methane Absorbing Action of the Ionization Type Zirconium Aluminum Gas Absorbing Agent Pump"

SOURCE: Shenyang ZHENKONG [VACUUM] in Chinese No 2, 81 pp 22-27, 63

ABSTRACT: Using experimental method, the methane pumping speed of the pump is obtained. The temperature of the filament of the thermal tungsten lamp and the effect of the ionization electron beam on the pumping speed are tested. A mass spectrometric analysis of the residual gases after the methane is pumped out is performed. Finally, there is a discussion of the mechanism of this pump for removing such organic gaseous molecules as methane. For the purpose of clarifying the complex physical and chemical action of methane absorption, this paper illuminates and introduces the gas absorbing agent pump through an experimental technique.

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CSO: 4009/312

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